OCTOBER 1992

UPDATE ON HYDROELECTRIC POWER POTENTIAL IN SANTA CLARA VALLEY

Santa Clara Valley Water District

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SANTA CLARA VALLEY WATER DISTRICT

UPDATE ON HYDROELECTRIC POWER POTENTIAL IN SANTA CLARA VALLEY

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October 1992

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Objective

This report updates the findings and conclusions of previous studies and reports dealing with hydroelectric power in the Santa Clara Valley Water District (District) based on the conditions that presently exist in 1992. This report takes an objective look at the hydro potential at 3 sites; Anderson Dam, Calero Pipeline, and the Kirk/Page/Vasona complex. It is the intent of this report to present the factual potential of these 3 sites along with all technically feasible possible alternatives for future action. It is not the intent of this report to make any judgments on past actions nor future plans.

Background

The District has a long history of active involvement in evaluating and using alternate energy sources wherever feasible. After the passage of the Federal Public Utility Regulatory Policy Act (PURPA) in 1978, which created a market for small energy producers, the District initiated a series of studies to determine if and where there was a viable potential for producing hydroelectric energy in the Santa Clara Valley.

Tudor Engineering was contracted in 1978 to do an initial study of the potential for generating hydroelectric power in the valley. Tudor issued a report in November 1978, suggesting that 3 sites warranted further hydro potential consideration. These sites were Anderson Dam, Coyote Dam, and the Maple Avenue Turnout on the future Santa Clara Conduit. Tudor issued a subsequent report in June 1980, that covered the possibility of a hydro facility at Calero Dam. This report suggested that the only type of facility feasible at Calero was a conduit turbine/generator unit and that further studies would be necessary after more details were available on the actual design of the future Calero Pipeline.

These reports were followed in 1981 by a staff preliminary feasibility study on hydroelectric potential in the valley. The results of the staff studies suggested that 4 dam sites: Anderson, Calero, Coyote, and Lexington had sufficient hydroelectric potential to warrant further study.

Engineering-Science (ES) was contracted in 1982 to conduct detailed feasibility studies on the above 4 sites and to also conduct a preliminary feasibility study on the Kirk/Page Turnout complex off the Central Pipeline. ES issued a preliminary Power Generation Report in May 1983 that concluded that hydroelectric power generation was feasible at Anderson and Calero, was not feasible at Coyote and Lexington, and was marginally feasible at Kirk/Page. The District requested that this report be broken into 3 separate and more detailed reports.

ES issued a detailed feasibility report for hydroelectric power generation at Anderson Dam and an environmental assessment and negative declaration for the Anderson Dam Hydroelectric Facility in August 1983 recommending an 800 KW hydroelectric facility. The District agreed with the findings in these reports and proceeded to implement a project to build the recommended hydroelectric facility at Anderson Dam. This project was completed in July 1989.

ES issued a report on hydroelectric power generation at Calero, Coyote, and Lexington in November 1983. This report concluded that out of all the combinations available for generating energy at these

3 sites, only generation from the modulation of flows between the Calero and Almaden Valley pipelines was technically and economically feasible. ES recommended installing a 550 KW hydroelectric facility at Calero in conjunction with the construction of the Calero Pipeline. The District agreed with these findings but decided to postpone construction of the Calero facility until after the Calero Pipeline was in service.

ES issued an environmental assessment and negative declaration for the Kirk/Page turnouts in September 1984 and a detailed feasibility report for Kirk/Page in December 1984 that recommended a 500 KW hydroelectric facility. District staff questioned some of the assumptions used in this report and a staff feasibility study was conducted in 1985 on the Kirk/Page hydro potential. This study found 4 areas of concern with the assumptions used in the ES report:

1. The expected monthly releases from the Central Pipeline.
2. The recharge facility percolation rates.
3. The market value of the energy generated.
4. The release cutbacks due to high turbidity in the Central Pipeline water during certain times of the year.

A reanalysis was conducted by District staff using more conservative assumptions in these 4 areas. The reanalysis showed that while the conclusions in the ES report were optimistic, the more conservative assumptions in the reanalysis still supported the recommendation to proceed with a 500 KW hydro facility at Kirk/Page. Staff recommended proceeding with this project.

James M. Montgomery Consulting Engineers (JMM) was contracted by the District in 1986 to do a detailed Basis of Design for the Kirk/Page Hydro Project. JMM completed a preliminary Design Report in August 1987, recommending a 700 KW facility but suggested that this facility would be marginally feasible from a revenue/cost ratio. JMM modified this report in March 1988, based upon PG&E's standard offer #1 rate structure and included an analysis of transmitting the power directly to Vasona Pumping Plant. This report concluded that a 650 KW facility would be the optimum size but that it was still marginal based upon benefit/cost analysis and that transmitting the power to Vasona would only be feasible if PG&E was willing to wheel the power which they were not willing to do. The District postponed any action on the Kirk/Page facility until a later date.

Anderson Hydro Facility

The Anderson Hydro Facility was completed in July 1989. Table 1 shows the 1983 projected cost estimate for the project and Table 2 shows the 1983 projected Revenues and Expenses over a 30 year period. The actual construction cost was $2,143,000 which compares very favorably with the $1,926,000 projected construction cost. The actual financing was accomplished with 20 year 6.8 percent revenue bonds as compared to the projected financing of 8 percent over 10 years.

The final installed facility consists of 2 identical turbine-generator units each rated at 470 KW. Each unit has a design flow rate of 35 cfs and a design head of 165 ft. The units first generated energy in December 1988. Table 3 shows the actual energy and revenue generated through the end of 1991. As this table shows, the total revenue generated by this facility through 1991 has been $347,276. There appears to be 3 major areas that have resulted in this large shortfall of actual revenue to projected revenue: the recent drought, the assumptions used in the projected generation capability, and the assumptions used in the rate projections.

For 5 of the last 6 years the Santa Clara Valley has experienced significantly lower rainfall amounts than the historical average. Anderson Reservoir had been drained for maintenance just prior to this period and never had a chance to regain its normal average storage. As a result, there has been very little water available in Anderson for hydro generation during the period that the hydro facility has been in service. This has produced a significantly lower energy generation from that projected in Table 2.

All of the previous reports on hydro potential have used SYSMOD simulations as an input to their generation potential projections. SYSMOD is a District computer model predicated on continuing growth based on expanding water supplies. This is a good basis for projecting future water needs in Santa Clara County but may lead to optimistic projections for hydro potential. In addition to water availability, other factors such as water quality and system configuration determine the amount of water turned out for hydro generation. These factors tend to lower the amount of hydro generation from that projected based solely on water availability. It is probable that even if there had been no drought, the actual energy generation from Anderson would have been less than that projected in Table 2.

The District was able to negotiate a contract with PG&E to purchase the Anderson power under Standard Offer #4 (SO4) which was the most beneficial plan offered to small producers. This purchase plan is no longer offered and the only plan available in 1992 is the much lower Standard Offer #1 (SO1). The actual SO4 rates are lower than those projected in Table 2. The projections assumed a revenue rate of 9.3¢ per KWh in 1988 with an 8 percent annual escalation while the average rate achieved under SO4 was 6.7¢ per KWh in 1988 with less than 7 percent annual escalation thereafter. As a result, actual revenue rates achieved for Anderson were not as high as had been projected, resulting in a considerable revenue shortfall. Table 4 shows a comparison between the 1983 rate projections and the 1992 S04/S01 rate projections.

The statistical data for water yields in the Coyote/Anderson watershed are shown in Table 5. This data shows that the historical average yield for the Coyote/Anderson watershed is about 47,000 af. Operating data also shows that of this amount, about 30,000 af would be available for recharge turnout with the rest used to supply the treatment plants. This produces about 82 af per day or 41 cfs for use in hydro generation. It is reasonable to assume that with these yields the average level in Anderson would be maintained at or above the level of the middle discharge gate which is at elevation 535 feet and results in an available driving head of 112 feet. These values produce an average power production of 330 KW or an average annual energy production of 2,890,800 KWh/year as opposed to the 4,177,000 KWh/year assumed in the projections in Table 2.

Because this analysis which is based upon historical data for the average annual yield of the Coyote/Anderson watershed is much lower than the 1983 projections, additional analyses were conducted using SYSMOD with projected 1995 water demands and various system configurations and water priorities. The results of all analyses are shown in Table 6 which confirms that the above watershed yield analysis produces an average KW demand that could be obtained from Anderson Hydro when operated in an optimum power production mode.

The contracted revenue rates in SO4 expire in December 1998. At that time contracted revenue rates will revert to SO1. Using actual values to date and the above assumptions for future projections, Table 7 was generated as an updated Table 2 based upon 1992 knowledge and data. The results from

Table 7 are shown in graphic form in Figures 1-5. These projections indicate that unless more water is available for recharge through the Anderson Hydro Facility and/or there is a significant increase in the revenue rates from present projections, Anderson Hydro will not generate enough revenue to return initial costs until 2010.

Calero Modulating Hydro Facility

Later

Kirk/Page/Vasona Hydro Facility

Later

TABLE 1
PROJECTED PROJECT COSTS AND BOND/NOTE SIZING

Anderson Hydro—1983

Project Costs	
Engineering design[1]	$ 214,000
Construction costs[2]	1,926,000
Total Project Costs[3]	$2,140,000
Construction Financing Requirement[4]	
Construction (90 percent of construction costs; 10 percent withheld)	$1,733,400
Engineering design	214,000
Total Construction Financing Requirement	$1,947,400
Bond/Note Sizing	
Estimated total project costs	$2,140,000
District carrying costs (interest during construction)[5]	97,300
Bond financing (issuance and discount)[6]	93,200
Principal Amount	$2,330,500
Estimated Annual Debt Service	
Year 1	$233,000
Year 2	275,900
Year 3	338,400
Year 4	389,400
Year 5	389,400
Year 6	389,400
Year 7	389,400
Year 8	389,400
Year 9	389,400
Year 10	389,400
Average Estimated Debt Service[7]	$347,300

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[1] Assumed at 10 percent of total project costs.

[2] Includes construction costs, design contingency, and construction management costs.

[3] Engineering estimate escalated to start of construction. Includes engineering design, design contingency, and construction management.

[4] Cash financing requirement during construction period. Reimbursed with interest upon sale of bonds at completion of construction.

[5] Interest on cash financing during construction at 9 percent/year for 1 year; one-half balance on construction costs, full balance on engineering design costs.

[6] Estimated at 4 percent of principal amount.

[7] At 8 percent, 10 years.

TABLE 2

PROJECTED REVENUES AND EXPENSE

Anderson Hydro—1983

	Year	Annual O&M[8] ($)	Debt Service[9] ($)	Total Expenses ($)	Power Revenues[10,11] ($)	Net Annual Revenue ($)
(1)	1986	20,000	233,000	253,000	309,100	56,100
	1987	21,400	275,900	297,300	338,800	41,500
	1988	22,900	338,400	361,300	360,500	(800)
	1989	24,500	389,400	413,900	389,300	(24,600)
(5)	1990	26,200	389,400	415,600	420,500	4,900
	1991	28,100	389,400	417,500	454,100	36,600
	1992	30,000	389,400	419,400	490,500	71,100
	1993	32,100	389,400	421,500	529,700	108,200
	1994	34,400	389,400	423,800	572,100	148,300
(10)	1995	36,000	389,400	425,400	617,800	192,400
	1996	39,300	______	39,300	667,300	628,000
	1997	42,100	______	42,100	720,700	678,600
	1998	45,000	______	45,000	788,300	743,300
	1999	48,200	______	48,200	840,600	792,400
(15)	2000	51,600	______	51,600	907,800	856,200
	2001	55,200	______	55,200	980,500	925,300
	2002	59,000	______	59,000	1,058,900	999,900
	2003	63,200	______	63,200	1,143,600	1,080,400
	2004	67,600	______	67,600	1,235,100	1,167,500
(20)	2005	72,300	______	72,300	1,333,900	1,261,600
	2006	77,400	______	77,400	1,440,700	1,363,300
	2007	82,800	______	82,800	1,555,900	1,473,100
	2008	88,600	______	88,600	1,680,400	1,591,800
	2009	94,800	______	94,800	1,814,800	1,720,000
(25)	2010	101,400	______	101,400	1,960,000	1,858,600
	2011	108,500	______	108,500	2,116,800	2,008,300
	2012	116,100	______	116,100	2,286,200	2,170,100
	2013	124,300	______	124,300	2,469,100	2,344,800
	2014	133,000	______	133,000	2,666,600	2,533,600
(30)	2015	142,300	______	142,300	2,879,900	2,737,600

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[8] Engineering estimate of 1986 cost escalated 7%/year.

[9] See Table 1.

[10] Engineering estimate of 1986 power revenue based on 7.4¢/kWh escalated 8%/year.

[11] Power revenue based on generation of 4,177,000 kWh/year.

TABLE 3
ACTUAL POWER PRODUCTION AND REVENUE

Anderson Hydro

Month	1988	1989	1990	1991	1992
January	-0- -0-	123,500 KWH $9,226	57,500 KWH $4,586	140,000 KWH $11,884	-0- -0-
February	-0- -0-	147,000 KWH $10,975	127,002 KWH $10,132	-0- -0-	-0- -0-
March	-0- -0-	500 KWH $39	244,501 KWH $19,553	-0- -0-	58,000 $5,309
April	-0- -0-	87,500 KWH $6,528	186,691 KWH $15,228	-0- -0-	204,500 $18,748
May	-0- -0-	77,000 KWH $5,541	222,000 KWH $17,146	105,500 KWH $8,619	210,500 $18,590
June	-0- -0-	49,000 KWH $3,576	256,501 KWH $19,733	157,000 KWH $12,872	162,500 $14,404
July	-0- -0-	7,000 KWH $511	166,501 KWH $12,843	167,500 KWH $13,726	173,000 $15,332
August	-0- -0-	3,500 KWH $268	263,000 KWH $20,272	177,500 KWH $14,522	139,500 $12,360
September	-0- -0-	292,000 KWH $21,087	269,501 KWH $20,685	5,000 KWH $414	137,500 $12,172
October	-0- -0-	238,500 KWH $17,204	163,036 KWH $12,597	88,000 KWH $7,206	note[1]
November	-0- -0-	10,500 KWH $789	108,000 KWH $8,596	75,500 KWH $6,388	note[1]
December	92,500 KWH $6,321	183,500 KWH $13,754	181,501 KWH $14,455	-0- -0-	note[1]
TOTAL	92,500 KWH $6,321	1,219,500 KWH $89,498	2,245,734 KWH $175,826	916,000 KWH $75,631	1,111,111 KWH[1] $100,000[1]
	$6.7¢/KWH	$7.3¢/KWH	$7.8¢/KWH	$8.3¢/KWH	$9.0¢/KWH

POWER GENERATED: 5,584,845[1]
REVENUE: $447,276[1]
AVERAGE RATE: 8.0¢/KWH

NOTE: [1] Totals include a projected year-end estimation for October, November, and December 1992 that result in $100,000 of power revenue for the year.

TABLE 4
1983 VS 1992 RATE PROJECTIONS

Year	1983 Rate Projections[1]	1992 Rate Projections[2]
1986	7.40	5.79
1987	7.99	6.16
1988	8.63	6.70
1989	9.32	7.34
1990	10.07	7.84
1991	10.87	8.34
1992	11.74	9.01
1993	12.68	9.75
1994	13.70	10.54
1995	14.79	11.39
1996	15.98	12.24
1997	17.25	13.14
1998	18.63	14.00
1999	20.13	4.97
2000	21.74	5.41
2001	23.47	5.94
2002	25.35	6.57
2003	27.38	6.82
2004	29.57	6.90
2005	31.94	7.39
2006	34.49	7.76
2007	37.25	8.18
2008	40.23	8.62
2009	43.45	9.30
2010	46.92	10.05
2011	50.68	10.87
2012	54.73	11.75
2013	59.11	12.70
2014	63.84	13.72
2015	68.95	14.83
2016	74.46	16.03
2017	80.42	17.32
2018	86.85	18.71
2019	93.80	20.22
2020	101.31	21.84

NOTES:

1. Engineering estimate of 1986 power revenue oF 7.4¢/kWH escalated 8%/year thereafter.
2. Projections are as follows:

1986-1998	S04 Rate Table B-1, with year 1998 estimated
1999-2011	California Energy Commission, December 1991 Forecast of PG&E S01 rates
2012-2020	Year 2011 rate plus 8% per year annual increase

TABLE 5

RESERVOIR INFLOW HISTORY REPORT

Year	Anderson Total (af)	Coyote Total (af)
1967	11,457	58,203
1968	763	5,643
1969	20,655	94,410
1970	3,379	48,961
1971	1,055	11,615
1972	238	7,111
1973	17,529	63,132
1974	6,461	37,700
1975	7,322	34,083
1976	60	226
1977	6	917
1978	66,060	58,430
1979	16,023	8,901
1980	87,927	68,371
1981	24,958	16,231
1982	86,449	83,912
1983	149,662	81,120
1984	3,160	9,685
1985	1,153	7,741
1986	16,173	71,839
1987	283	5,744
1988	56	2,089
1989	15	3,283
1990	58	1,959
1991	5,683	15,229

TABLE 6

ANDERSON HYDROELECTRIC POWER PLANT POWER GENERATION ANALYSIS

Case Description	Monthly Ave Head (ft)	Ave Flow (cfs)	Annual Ave Power (MWH)	Ave Demand (KW)
Maximum Use at Design Conditions	165[1]	70[1]	5263	601[2]
1981 Hydro Power Feasibility Report	170[1]	80[1]	4620	527
	135	53	3647	416[3]
1983 Hydro Power Report by ES	165[1]	70[1]	4177	477
1992 Update on Hydro Power Potential	112	41	2891	330
1995 Demands with Priority at Coyote Turnout[4]	134	50	3409	389
1995 Demands without Priority at Coyote Turnout[4]	111	43	2908	332
1995 Demands with Priority	135	39	2739	313
without Priority[5]	38	12	644	73
Actual Use				
1989			1220	139
1990			2246	256
1991			916	104
1992 thru August			948	162

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[1] Design Conditions

[2] Requires Constant Flow of 70 cfs=50,589 af/yr

[3] 1995 Demands, Potential Recharge Rates, with Priority at Coyote RWT at Design Head=170 ft, Design Flow=80 cfs

[4] 1967-1991 Hydrology

[5] 1987-1991 Drought Hydrology

TABLE 7

PROJECTED REVENUES AND EXPENSES

Anderson Hydro—1992

Year	Annual O&M ($)	Debt Service ($)	Total Expenses ($)	Power Revenues ($)	Net Annual Revenue ($)	Net Cumulative Revenue ($)
1988	-0-	-0-	-0-	6,321	6,321	6,321
1989	12,250	108,287	120,537	89,498	-31,039	-24,718
1990	26,200	216,575	242,775	175,826	-66,949	-91,667
1991	28,100	216,575	244,675	75,631	-169,044	-260,711
1992	30,000	216,575	246,575	100,000	-146,575	-407,286
1993	32,100	216,575	248,675	321,750	73,075	-334,211
1994	34,400	216,575	250,975	347,870	96,895	-237,316
1995	36,000	216,575	252,575	375,870	123,295	-114,021
1996	39,300	216,575	255,875	403,920	148,045	34,024
1997	42,100	216,575	258,675	433,620	174,945	208,969
1998	45,000	216,575	261,575	462,000	200,425	409,394
1999	48,200	216,575	264,775	164,010	-100,765	308,629
2000	51,600	216,575	268,175	178,530	-89,645	218,984
2001	55,200	216,575	271,775	196,020	-75,755	143,229
2002	59,000	216,575	275,575	216,810	-58,765	84,464
2003	63,200	216,575	279,775	225,060	-54,715	29,749
2004	67,600	216,575	284,175	227,700	-56,475	-26,726
2005	72,300	216,575	288,875	243,870	-45,005	-71,731
2006	77,400	216,575	293,975	256,080	-37,895	-109,626
2007	82,800	216,575	299,375	269,940	-29,435	-139,061
2008	88,600	216,575	305,175	284,460	-20,715	-159,776
2009	94,800	108,288	203,088	306,900	103,812	-55,964
2010	101,400	-0-	101,400	331,650	230,250	174,286
2011	108,500	-0-	108,500	358,710	250,210	424,496
2012	116,100	-0-	116,100	387,750	271,650	696,146
2013	124,300	-0-	124,300	419,100	294,800	990,946
2014	133,000	-0-	133,000	452,760	319,760	1,310,706
2015	142,300	-0-	142,300	489,390	347,090	1,657,796
2016	152,300	-0-	152,300	528,990	376,690	2,034,486
2017	163,000	-0-	163,000	571,560	408,560	2,443,046
2018	174,400	-0-	174,400	617,430	443,030	2,886,076

NOTES:

1. 1988-1992 revenues are actual values, with the final three months of 1992 estimated.
2. 1992-1998 revenues are based on a continuous 330 kW output at SO-4 rates.
3. Post-1998 revenues are projected using a continuous 330 kW output at projected S01 rates.
4. O&M expenses were taken from 1983 projections; see Table 2.
5. Actual O&M costs for 1988-1992 were higher than those shown in the table. This is mainly attributable to startup costs which are not expected to be carried throughout the project.

ANDERSON HYDRO

HYDROLOGICAL POTENTIAL

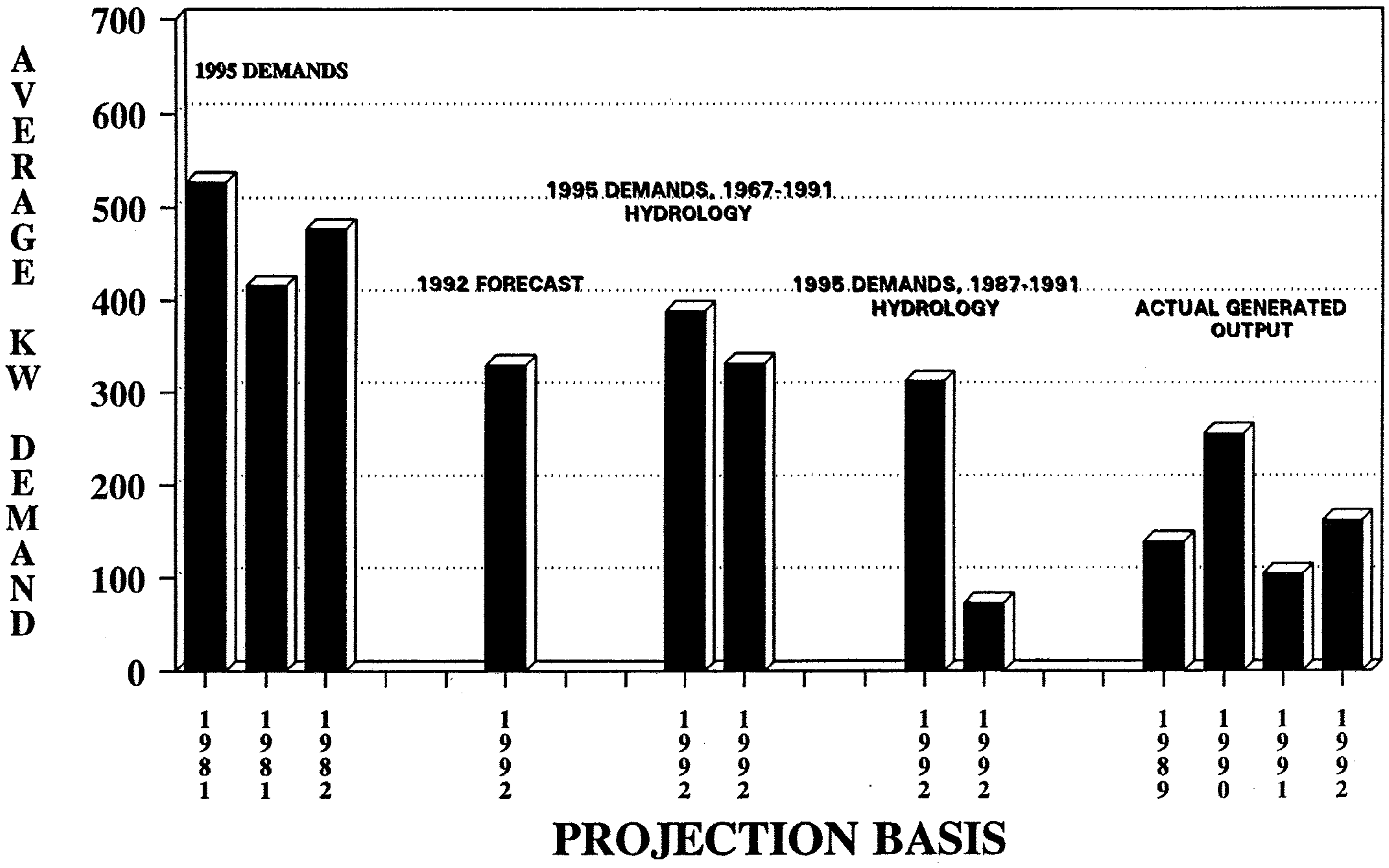

FIGURE 1

ANDERSON HYDRO

1983 AND 1992 POWER REVENUE PROJECTIONS

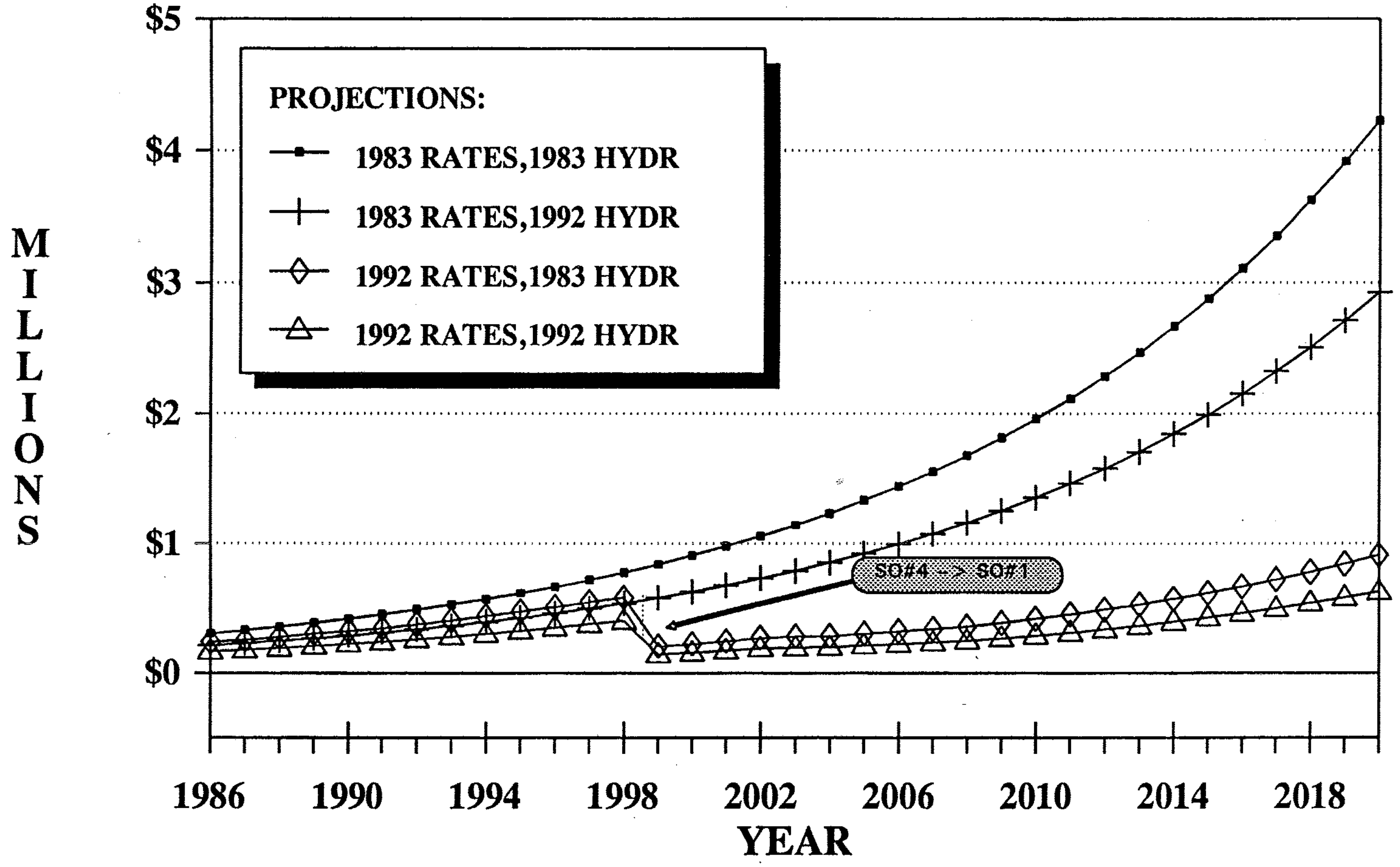

FIGURE 2

ANDERSON HYDRO

PROJECTED NET ANNUAL REVENUE COMPARISON

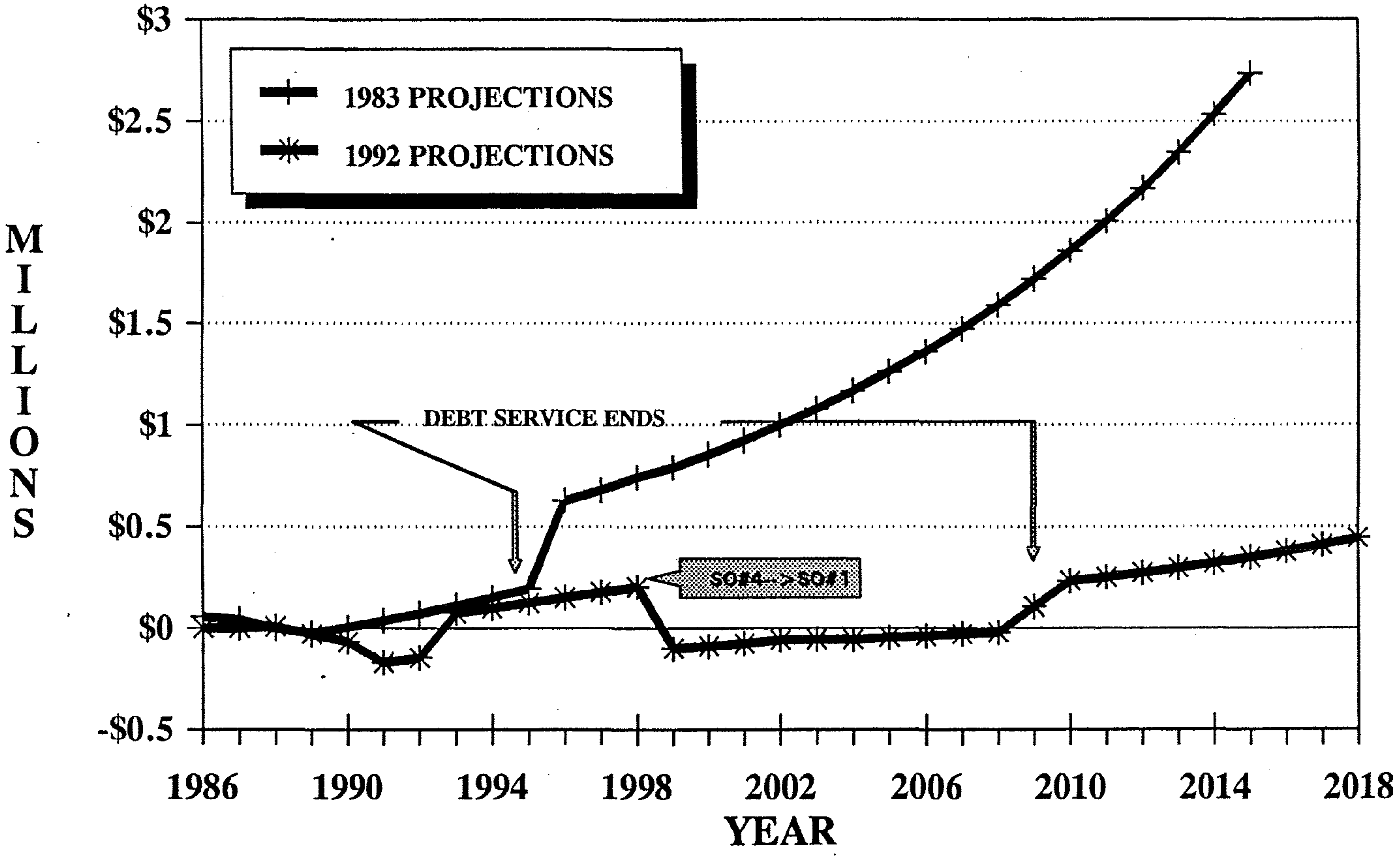

FIGURE 3

ANDERSON HYDRO

1992 NET ANNUAL REVENUE PROJECTIONS

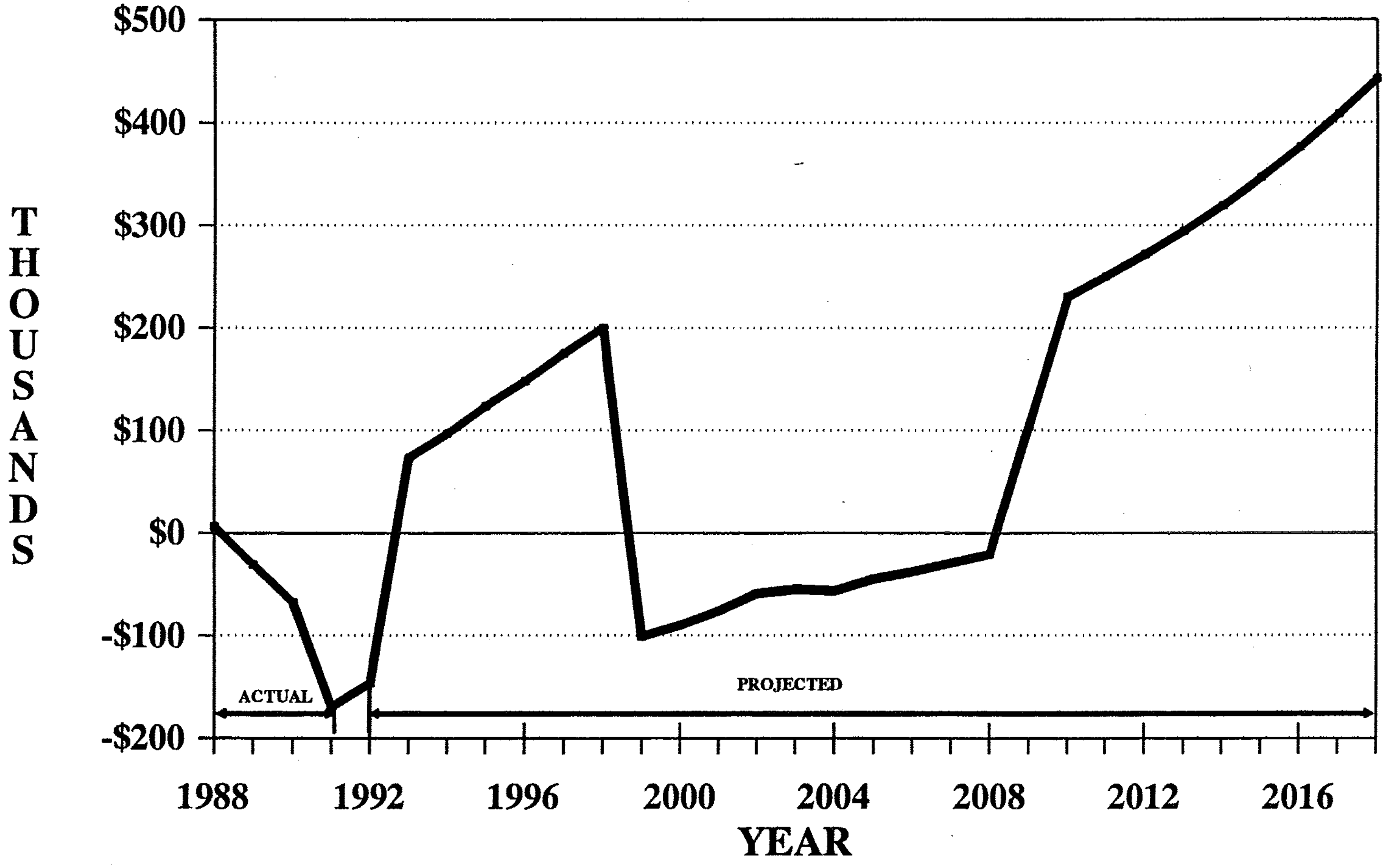

FIGURE 4

ANDERSON HYDRO

1992 PROJECTIONS

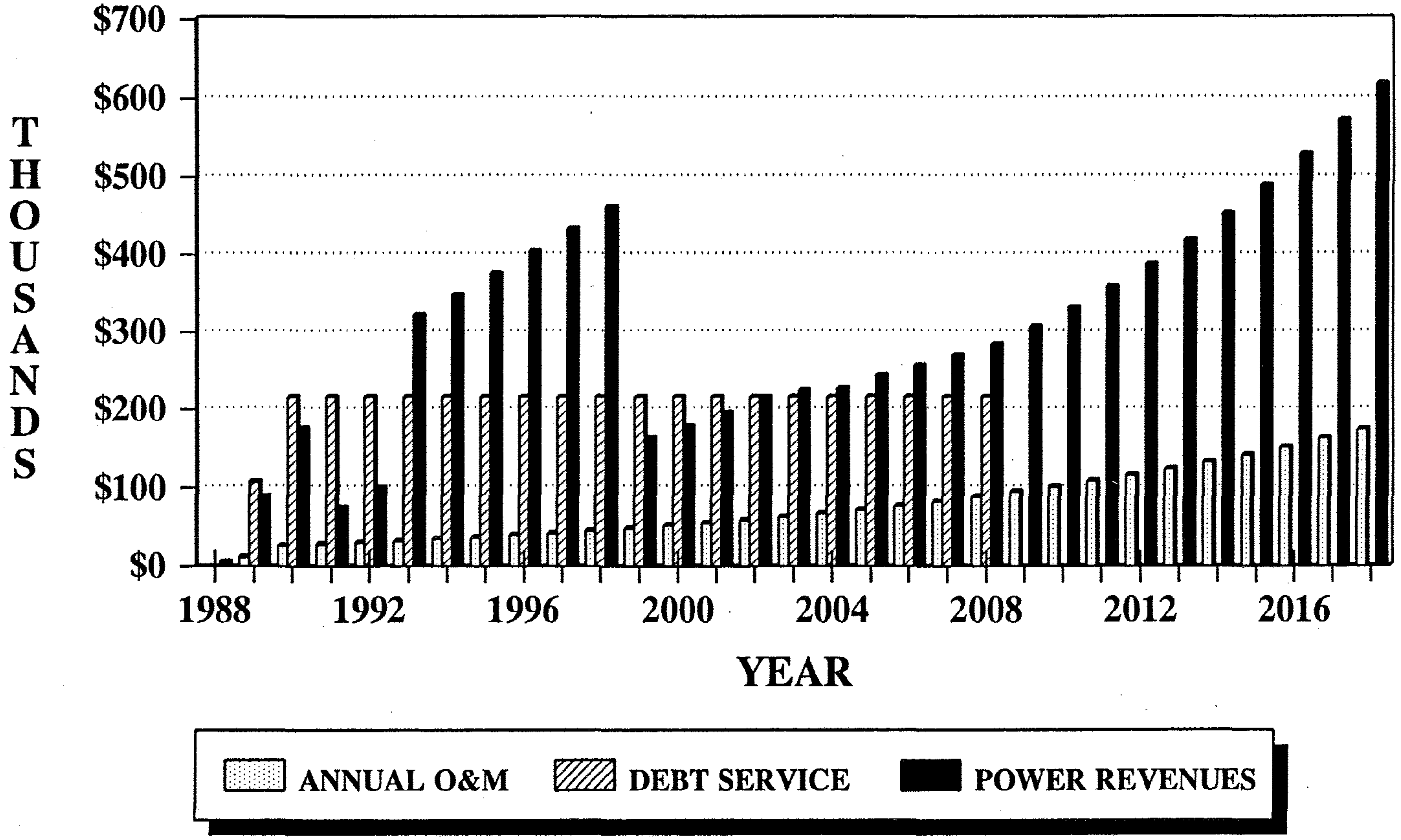

FIGURE 5